Canada

MOSST
Background Paper

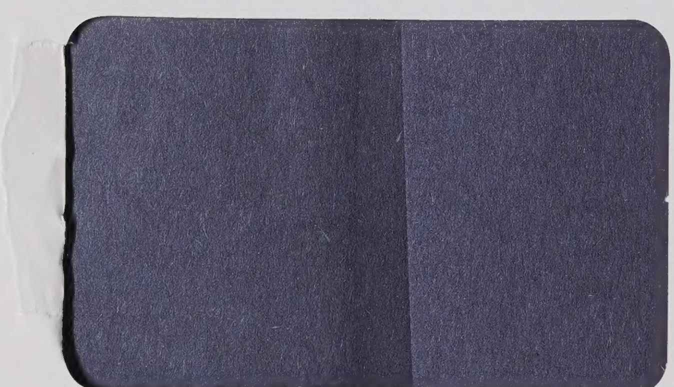
19

THE CANADIAN SPACE PROGRAM
PLAN FOR 1981/82 - 1983/84

April 1981

Ministry of State
Science and Technology
Canada

Ministère d'État
Sciences et Technologie
Canada



19

THE CANADIAN SPACE PROGRAM
PLAN FOR 1981/82 - 1983/84

April 1981

Cat. No. ST 41-3/1981-19E

ISBN 0-662-11528-7

TABLE OF CONTENTS

FOREWORD

The announcement by the Minister of State for Science and Technology on the space program on April 9, 1981 and this Background Paper are based on proposals for space projects made by the Departments of Communications, Energy, Mines and Resources, Environment and Fisheries and Oceans and reviewed by the Interdepartmental Committee on Space.

INTRODUCTION

The Minister of State for Science and Technology, the Honourable John Roberts, announced on April 9, 1981, that the government had approved a three-year $64 million space plan. This plan together with the $196 million previously approved means that the government of Canada will spend $260 million on space during the next three years.

The plan has three major characteristics.

1. It is a multi-year plan.
2. It aims at diversifying even further Canadian space competence and usage.
3. It provides considerable further support to technological development in the Canadian space industry.

The purpose of this background paper is to outline the space program and to provide details on the projects included in the three-year plan.

BACKGROUND

Since becoming the third country (after the USSR and the USA) in the world to enter the space age when the Canadian-designed and built ALOUETTE I scientific satellite was launched in 1962, the Canadian government has invested a total of about $600 million in the nation's space program. In addition to the many benefits directly attributable to the use of space (e.g. better communications, weather forecasting and resource management), the national space program has led to:

(a) the creation of a government/private sector jointly owned commercial satellite communications corporation (Telesat) that has invested $335 million in space and generated total net earnings of $31 million;

(b) the creation of a space manufacturing industry with total sales since 1961 of approximately $650 million and which, in 1979, employed 2240 people mostly in direct high technology jobs and had sales of $140 million of which 43% were in the export market;

(c) the development of space science and technology expertise in eight Canadian universities; and

(d) the establishment within government of three major centres of expertise in space technology employing more than 300 people and with annual capital, operating and salary expenses totalling $50 million.

From the earliest days of the space age, the Canadian government has recognized the vital role it must play in fostering the use of space technology for the economic and social benefit of the country. As a result of this understanding and commitment, Canadians are one of the largest users of space technology in the world (on the basis of satellite capacity per capita), enjoy a communications infrastructure second to none, are able to utilize satellites for resource management, weather forecasting and navigation, and have developed an indigenous space industry capable of meeting many of our domestic needs. In the process, we have developed an international reputation for technical and operational excellence. We are a very visible part of the small cadre of nations capable of influencing the development of new applications of space technology and this places us in an enviable position as the use of space continues to grow at an increasing rate. Some of the benefits Canada has received from its space activities are given in Appendix I.

THE ROLE OF GOVERNMENT IN SPACE

Without exception, the space activities of the technologically advanced countries of the world are dominated by government sponsored programs. There are no countries where the users of space are not predominantly government or government-financed, or where major space manufacturing industries exist in the absence of strong government commitments. Even in the relatively mature commercial market for satellite communications, governments (with the notable exception of the United States) are either the purchasers of systems or, even in the case of the United States, strongly influence the procurement of systems. As a matter of deliberate policy, the governments of all technically sophisticated nations have invested, and are continuing to invest, in such diverse areas as defence, national sovereignty, social and cultural development, the advancement of science, the provision of economic services, industrial development and the enhancement of high technology capabilities.

While these objectives indicate the types of benefits governments expect from their space programs, it is the very nature of space activities that dictates the large scale government involvement evident throughout the world. It is characteristic of space that the most promising applications generally have been in areas where governments are the primary customer or provider of service (e.g. telecommuni-

cations both domestic and international, military systems, navigational aids, weather and environmental monitoring and forecasting, search and rescue, natural resource monitoring and management, advancement of scientific knowledge). This trend will continue as governments in developing countries become convinced that space-borne systems are the most economical, and sometimes the only means of meeting some of their needs.

Additionally, most space activities involve substantial R&D at the forefront of a number of high technology disciplines (e.g. materials, electronics, mechanics and systems engineering) where the technical risks are too high for most commercial corporations. The leading-edge nature of space technology means that applications are innovative, sometimes offering the capability to provide new services in advance of the recognition of a commercial market for these services.

Stimulation and development of these potential markets often requires pre-operational demonstrations, not only to show prospective customers the capabilities of a new system, but to aggregate customer demand and to establish the economics of the new service. As a result, space programs have gestation periods from five to ten years (between original concept and production of the first flight unit) with high front-end costs. This creates relatively long payback periods for recovery of investments. All of these factors combine to make space development a very risky undertaking for normal commercial investment until such time as the technology is proven and the market developed. These are some of the reasons why it has been necessary for governments to take a leading role in technology and market development.

This sequence of events (government initiative in technology and market development followed by commercial exploitation of services) was followed for satellite communications which has now become a multi-billion dollar business. The satellite remote sensing business is developing in the same way.

The fact that space R&D activities around the world are predominantly government sponsored and that, even in commercial applications, governments are the major purchasers of space systems has profound implications. As the most significant forces in the development and use of space, governments are able to use their space programs or procurements as instruments of national policy. Consequently, it is often governments and not free-market considerations that set the direction and speed of new developments; determine the nature, content, terms and conditions of foreign industry participation in programs; control the transfer of technology between nations; establish the level and nature of domestic space industry capability; and seek international cooperative programs to further their national objectives at lower cost. In this environment, it

is essential that the Canadian government continue to take an active role in the pursuit of new applications, the development of technology, and the fostering of our space industry.

ORGANIZATION OF THE CANADIAN SPACE PROGRAM

Within government, the program is centered in three departments - the Department of Communications (DOC), the National Research Council (NRC) and the Department of Energy, Mines and Resources (EMR). DOC is the largest player and has the most expertise. DOC space activities include basic research, technology development, communications applications development, industrial development, support of space activities in other departments (particularly DND), and the provision of national laboratory and testing facilities such as the David Florida Laboratory and the Controls Laboratory. DOC's space programs have accounted for almost half of total government expenditures on space and include the ISIS program (started by the Defence Research Board and transferred to DOC in 1969), the Communications Technology Satellite (CTS) or HERMES program, the ANIK-B communications experiments, the David Florida Laboratory extension, and the program to raise the Canadian content of the ANIK-C and ANIK-D satellites. Its space budget is about $35 million.

NRC, with the second largest program, has been responsible for slightly more than a quarter of total government expenditures in space. Its programs have included various scientific rocket and balloon campaigns, the remote manipulator system (RMS), the cooperative space science program with NASA, and the provision of various national facilities such as the Churchill Research Range and a scientific balloon-launching facility at Gimli Manitoba. NRC has primary responsibility for the support of space science facilities for use by both government and university scientists. NRC's space budget is about $20 million.

The third major space program is the satellite remote sensing program managed by the Canada Centre for Remote Sensing (CCRS) of EMR. It has accounted for about one eighth of total government expenditures in space. CCRS has been the lead agency for Canada's participation in the U.S. LANDSAT and SEASAT remote sensing programs, the SURSAT program to evaluate Canadian needs for surveillance data from satellites, an airborne remote sensing program, Canadian participation in the European Remote Sensing Program, and the provision of specialized data processing services to users of remote sensing data. Its budget is about $10 million. It has concentrated on making use of existing U.S. remote sensing satellites and thus has been more oriented to operations and data processing and less to space hardware development.

In addition to the civilian space program discussed so far, the Department of National Defence (DND) has undertaken R&D directed at the military application of space technology. Currently approved programs total $18.8 million to FY 1983/84 and include Canada's participation in satellite navigation system (NAVSTAR), search and rescue satellite development (SARSAT), and the development of ground terminals for military satellite communications systems. New programs currently being planned in cooperation with the Department of Defence in the United States will require about $30 million to FY 1984/85. These new programs would emphasize the use of space-based surveillance for military applications and the augmentation of DND's space-based communications system.

Several other departments are interested in using space to meet their operational needs. The Department of Transport (DOT) is assisting DND in the investigation of satellites for search-and-rescue operations. The Department of the Environment (DOE) operates a network for the reception and distribution of data from U.S. meteorological satellites. These data are used in preparing forecasts of weather and ice conditions. Finally, scientists from a number of departments have participated in experiments using other research satellites of the U.S. The various departments are served by an interdepartmental secretariat.

SPACE POLICY

The Canadian Policy for Space was announced by the government in 1974 (Appendix II summarizes the Policy). It directed, among other things, that "the utilization of space systems for the achievement of specific goals should be through activities proposed and budgeted by departments and agencies within their established mandates". In order to ensure a proper degree of coordination of the space activities of departments and agencies, a small full-time secretariat was created to serve the Interdepartmental Committee on Space (ICS). In 1975, in recognition of the critical influence government programs had on the Canadian space industry, the government assigned to the ICS the additional responsibility of coordinating space procurement activities.

This approach to space worked well in the mid-70's. Canadian interests in space technology and the opportunities for its application corresponded fairly closely to the mandates of individual departments and agencies. Furthermore, the economy was sufficiently strong to provide the revenue needed to accommodate most proposals. By 1978, this approach was showing signs of weakness. Space technology was finding many new applications which went well beyond the interests of any single department and fiscal restraint demanded that choices be made among various proposals.

At the request of the ICS, MOSST analyzed the effectiveness of the government's approach to space taking into account the need for the coordination of space activities, for the development of a technological base, for strategic planning, for establishing priorities and for making optimum use of limited technical and scientific resources. Concurrently, the Canadian space industry argued for a more focussed approach. The Air Industries Association of Canada (AIAC) submitted a brief along these lines to the Prime Minister in October 1979.

The MOSST analysis and the AIAC submission clearly showed that, from the point of view of both the government and industry, there were weaknesses to the existing approach to space that limited the scope and benefits of the program. They both concluded that correction of these deficiencies was essential to the more efficient and effective use of the government's space resources and to the establishment in the space industry of an environment favourable to industrial investment. In response to these concerns, the Prime Minister, on 31 July 1980, assigned the Ministry of State for Science and Technology the leadership role with respect to space policy and development. As a first step, the Ministry became the lead department in the areas of space research and development policy and coordination of space activities among government departments and agencies. Responsibility for the ICS was, consequently, transferred to the Ministry. Further work is being done on the best way to organize the space program.

The announcement of a multi-year plan which aims at developing Canadian expertise to use space and at strengthening the Canadian space industry is a further important step in correcting the weaknesses identified by MOSST and the AIAC.

THE SPACE PLAN

The Canadian space program rests on two basic premises. The first is that the use of space can contribute significantly to the attainment of social, cultural and economic goals. The needs of mission-oriented departments are the basis for the program. The second is that there are economic benefits to be obtained from the creation of a strong industry to meet our needs and which is able to compete in the international market place.

Technically, the program has been very successful and this technical excellence has led in turn to the development of important commercial markets with even larger ones in the offing. The program is designed, on the one hand, to make better use of the technologies that have been developed, to improve them and to develop new ones to meet foreseen needs,

and, on the other hand, to cash in on the commercial opportunities that have developed or promise to materialize in the near future, and to maintain and strengthen the industrial base that has created these opportunities.

The plan for 1981/82-1983/84, together with previously approved Space activities will allow Canada to maintain and build its existing strengths in the use of space for communications and scientific purposes while at the same time developing a major new thrust in the area of remote sensing. This new thrust is in response to recent technological developments that have the promise of providing needed services in the most economical way. More than 60 per cent of the new expenditures will be for remote sensing projects.

(a) Remote Sensing

In the area of remote sensing, the long-term objective is the use of satellites for resource management as well as territorial and environmental surveillance. A related objective has been to establish and maintain up-to-date information systems and promote their effective utilization. The projects are:

i) the up-grading of the Prince Albert and Shoe Cove earth stations to make optimum use of the data which will be received from LANDSAT-D, the first of which will be launched in 1983. This project is beginning in 81/82 to permit Canadian stations to be ready to read out the satellite on time and to allow Canadian industry to have developed by then the necessary expertise and products to meet new market opportunities;

ii) technology transfer arrangements with the provinces in order to incorporate remote sensing data in their resource management systems;

iii) a basic radar R&D program to give Canada the technological and industrial competence to develop and establish a remote sensing satellite including a synthetic aperture radar (SAR). The SAR would provide day and night all-weather information on land and sea (especially ice) conditions of special importance in Arctic navigation;

iv) continued participation in the remote sensing program of the European Space Agency;

v) a project to study the feasibility of a technique which would measure, from a satellite, concentrations of chlorophyll in large bodies of water. The information from this sensor will help in predicting the type, size, and location of fish stocks; and

vi) a project to make more effective use of weather satellites and improve the accuracy of the forecast of weather, ice and other environmental parameters.

(b) Technological Development

The second major thrust of the plan is to increase and diversify the technological capabilities of the Canadian space industry. Technology development is an essential element of the space program because of the rapidly changing nature of this leading-edge technology. This program provides the government with the technological information required to assess future developments in the application of space to meet national needs and at the same time allows the industry to develop and maintain the up-to-date technological base required to seize new market opportunities. In the plan, more than 30 per cent of the new allocation is for technology development in industry. Included are:

i) an increase in DOC's current technology development programs. These programs are oriented mainly towards the development of sub-systems and components, with increasing emphasis on those related to earth stations capable of meeting future domestic and foreign requirements. The programs will also lead to the creation of new satellite technology incorporating the latest communications techniques;

ii) a key technology development program aimed at assisting the diversification of industry's capabilities into new application areas;

iii) a project to establish in Canada a basic capability for developing a family of advanced solid-state devices (Gallium Arsenide Field Effect Transistors). These have become an essential component in the application of new communications technology; and

iv) continued participation in the definition phase of the L-Sat program with the

expectation that the L-Sat program would provide Canada with the right to purchase and use the L-Sat spacecraft platform for Canadian needs, develop a world market for Canada's expertise in large solar power-sub-systems, and maintain systems integration and test expertise. A decision on Canada's participation on the construction phase of the program will be taken later in 1981.

(c) Communications

In the area of communications, the government's objective is to foster the development of new and improved satellite communications. The plan allocates new funds for:

i) the study of a possible system of direct broadcasting by satellite. A Regional Administrative Radio Conference will be convened in 1983 by the International Telecommunications Union to develop a radio-frequency and orbital position allocation plan for the Americas and the approved studies will enable Canada to participate meaningfully at that Conference;

ii) additional personnel resources for the Department of Communications in order to effectively manage and conduct an increased technology development program and to investigate new satellite applications; and

iii) the expansion of the DOC controls Laboratory to provide for satellite system development and procurement by Canadian industry and support for government space projects.

EXPENDITURES

The planned expenditures are summarized in the following table. These new financial commitments will maintain Canada's expenditures in space as presently funded projects reach completion over the next few years. For example, the first unit of the Remote Manipulator System has been delivered to NASA. Additional units have been purchased by NASA but these expenditures do not show in the following table.

SPACE PROGRAM EXPENDITURES

(Millions of Budget Year Dollars)

	80/81	81/82	82/83	83/84	3 Year Total
Current Space Projects	81.20	72.75	61.84	61.29	195.88
New Space	-	21.04	22.21	21.18	64.43
TOTAL		93.79	84.05	82.47	260.31

The allocation of the new funds to projects is shown in Appendix IV.

CONCLUSION

There are many good reasons why Canada will continue to be a major user of space in the future. Our geographical size and widely distributed bilingual and multi-cultural population are admirably suited to the type of service that can economically be delivered by satellite. Another important factor is the northern location of the Canadian landmass with its enormous areas of difficult terrain, remotely located resources, and three ocean boundaries -- including the Arctic. Areas of application, both current and future, include communications, broadcasting, weather observation and forecasting, remote sensing of the earth's surface and environment, search and rescue, aeoronautical and marine navigation, data collection, scientific exploration, military applications, and surveillance of Canadian sovereign territory. All of these applications are concerned with the generation, collection, movement, storage, and analysis of data and information about Canada, her resources, her people, and her businesses. Obviously, the availability of these services will be an essential factor in the continued social and economic development of the country. Control of the facilities and data flow will be important considerations in the maintenance of our cultural and economic sovereignty.

The space plan for 1981/82 to 1983/84 includes a selection of projects for commencement in 1981/82 that will allow Canada to maintain the momentum of its space program and to pursue new opportunities. The ground work is being laid to prepare industry for major new space application projects currently in the planning stages. The plan will continue to be updated on an annual basis to reflect newly defined needs and new opportunities arising from technological innovation.

Appendix I

Benefits of Space to Canada

The following paragraphs are intended to provide a brief glimpse of the more significant current and expected benefits which flow from the application of space technology.

Communications and Culture

Telesat's satellites have brought modern communications to areas of Canada which could not otherwise be economically served and have made it possible for more Canadians to receive both French and English language TV broadcasts. Although it is difficult to quantify the effect, it is clear that improved communications of all kinds have been particularly beneficial to the resource-rich but climatically-handicapped remote regions of the nation. Satellites have also demonstrated their competitiveness over well-established communications routes and have contributed to the maintenance and, in many instances, to the reduction of service rates. The increasing use of Telesat facilities augurs well for its future and, through normal growth, satellites will play an increasingly pervasive role in bringing to Canadians new services, including data of all kinds and computer communications, teleconference services and office-of-the-future concepts, and many more.

More advanced satellites, deriving from the HERMES and ANIK-B experiments, will make possible direct TV broadcasting to homes, improved program feeds to CATV systems, telemedicine, and tele-education. Other types of satellites, also in the planning stage, will be able to bring mobile communications to poorly-served areas of the country and are expected to prove invaluable to both government departments and the resource industries in improving their northern operations. The availability of greater program variety to a large portion of the population, in both official languages, will improve the market prospects for Canadian programming and promote mutual knowledge and understanding amongst provinces and regions. It will thus exert a beneficial influence upon the evolution of a Canadian culture and a greater sense of national pride and belonging. Internationally, through Teleglobe's involvement in INTELSAT, Canadians can now reach personal and business acquaintances in practically all countries of the world.

Remote sensing

Canada was the first country, outside the U.S.A., to receive and utilize data from the U.S. LANDSAT satellites; several other countries followed suit. The Canada Centre for Remote

Appendix I (cont'd)

Sensing and Canadian industry have become world leaders in the processing, interpretation and use of LANDSAT data as well as that obtained from aircraft. Twelve out of fourteen earth stations reading out LANDSAT data have been totally or largely built in Canada. Canadian data has proved of great value to federal and provincial government departments and to the agricultural, forest products and resource industries in a variety of ways, including crop inventory, forest and wildlife management, water resource management, land use mapping, ice reconnaissance, and mineral and petroleum exploration. Recent drought conditions in Canada have served to emphasize the potential contribution of improved satellite services for forest fire detection, water management and crop assessment. Increased shipping, especially tankers on our coasts, will require early detection of oil spills and other disasters at sea. Data from U.S. weather satellites has enhanced our ability to predict the weather over longer time periods.

For the future, it is proposed that Canada extend its LANDSAT association with the U.S. to the utilization of LANDSAT-D, the next generation in that series, the first of which will be launched in 1983. This satellite will provide better color and spatial resolution (30 vice 80 metres) than its predecessors and, consequently, more detail and improved identification possibilities.

In addition, data obtained from the U.S. experimental satellite SEASAT, in the context of the Canadian SURSAT (SURveillance SATellite) program, demonstrated the technical feasibility of producing, through the use of the synthetic aperture radar (SAR) technique, images of the earth under conditions of cloud, fog or darkness. The possibilities offered by this technique for monitoring ice coverage and drift and for detecting and pin-pointing human activity in coastal and ocean areas are of great interest to Canada in exercising proper surveillance over its vast territory and recently-extended coastal zones. The information available through this technique will also be essential for any large scale resource extraction and shipping in the North. Canadian development of a satellite system with this type of capability is under active consideration.

Also under consideration are techniques which would permit the detection and measurement of certain types of atmospheric and aquatic pollution. The most important advantage which satellites possess, over other sensor-carrying vehicles such as aircraft, ships, rockets or remote observation posts is their ability to provide broad synoptic views of large areas of the Earth under uniform lighting conditions and the repetitive coverage required to monitor changing phenomena

Appendix I
(cont'd)

such as crop growth, forest and land use and incipient pollution. Satellites provide data which could not, in some cases, be obtained by any other means and often data which could only be obtained by conventional techniques at exorbitant cost.

Science and Technology

The new knowledge gained from space R&D activities is needed by government and industry as a base for their decisions on the future use of space and the related investments required. Government sponsored R&D, whether in-house, in industry or in universities, and the resulting economic activity, serves to attract young people to this area by providing opportunities for training and achievement. Knowledge generated in this high technology sector very quickly permeates and stimulates similar activity in other sectors and can generate and maintain an atmosphere of dynamism and entrepreneurship which will benefit the nation in the long term. Canada has been a leader in many aspects of space science and last year entered into a six year cooperative space science project with NASA at a total cost of $42M.

Industrial and Economic

In 1975, total space-related sales of the entire Canadian space industry were of the order of $11M, of which 11% were exports. Five years later, in 1979, total sales had risen to about $140M, of which 43% were exports. Recent projections by the industry would indicate that five years hence -- in 1985 -- total sales could approach the $280M level, with about 66% in export sales. The steady development of a domestic capability can be exemplified by the increasing Canadian content and therefore import replacement in the four series of satellites contracted for by Telesat Canada; 13% for ANIK-A in 1972 rising to 50% for ANIK-D in 1979. Earth station contracts totalling $88M are practically 100 percent Canadian. A recent business enquiry conducted for ITC by the Air Industries Association of Canada indicates that total space-related sales could rise to a level of about $500 Million by the end of the decade.

The Canadian space industry employs about 2500 highly-skilled people (scientists, engineers, managers, technologists, technicians) and many times that many are estimated to be employed in associated and ancillary industries. This work force must not only be developed in terms of numbers and quality, but must also be involved in a sustained regime of projects and activities in order to prevent its dispersal and ensure its availability to participate in future Canadian ventures.

Appendix I
(cont'd)

Search and Rescue

Because of Canada's size, the remoteness of large portions of its territory and the harshness of the climate in such regions, the cost of search and rescue operations have been rising rapidly, particularly in the wake of escalating energy costs as well as increasing activity in these economically important regions. The use of satellites can achieve great economies in time and fuel by quickly identifying and circumscribing the area where a mishap has occurred. Canada has recently joined with France, the U.S.A. and the U.S.S.R. in an experimental venture called SARSAT (search and rescue satellite) to explore the potential of satellites for this purpose. A Canadian firm has been awarded contracts for the construction, not only of the two Canadian ground stations associated with this project, but of the three U.S. stations and the active elements of the French station as well.

National Security

In support of the collective needs of like-minded nations, Canada, through its NATO and NORAD alliances is becoming increasingly reliant upon satellites for improved communications, navigation, detection and monitoring. The Department of National Defence is planning significant new space programs in the period 1981 to 1985. These programs are expected to lead to the further introduction of satellite-based capabilities into Canadian defense programs and systems.

Appendix II

SUMMARY OF THE 1974 CANADIAN POLICY FOR SPACE

- The government endorses the principle that a Canadian industrial capability for the design and construction of space systems must be maintained and improved through a deliberate policy of moving government space research and development out into industry;

- government purchasing policies should encourage the establishment of a viable research, development and manufacturing capability in Canadian industry;

- Canada will continue to rely on other nations for launch vehicles and services and we should enhance access to such services by participating in the supplying nation's space program;

- departments involved should submit plans to ensure that, to the fullest extent possible, Canada's satellite systems are designed, developed and constructed in Canada, by Canadians, using Canadian components;

- Canada's primary interest in space should be to use it for applications that contribute directly to the achievement of national goals;

- utilization of space systems for the achievement of specific goals should be through activities proposed and budgeted by departments and agencies within their established mandates;

- at the international level, Canada's ability to use space should be furthered by participating in international activities for the use and regulation of activities in space, negotiating agreements for the continuing access to science, technology and required facilities, and maintaining knowledge of foreign space activities in order to respond quickly to potential opportunities and threats to national sovereignty, and at the national level, Canada's ability to use space should be furthered by the support of research appropriate to the need to understand the properties of space, the potentialities of space systems, and the search for potential applications, and technology programs to develop the industrial capability essential to meeting future requirements for operational space systems.

Appendix III

The Canadian Space Program

New Projects, 1981/82-1983/84

The following are brief descriptions of the new space projects which have been approved and are to commence in 1981/82. The projects are grouped into three categories: Remote Sensing, Technology Development and Communications.

REMOTE SENSING

Canadian Participation in LANDSAT-D

The purpose of this project is to upgrade the data reception, processing, dissemination, and image analysis capabilities of Canada in order to make full use of the data from the new, second generation technology of NASA's LANDSAT-D series of operational satellites, the first of which will be launched in 1983. This will permit EMR to continue to provide Canadian users with the best available data and provide the industry with the opportunity to maintain its technical and marketing leadership in this field.

The LANDSAT satellite system gives information about the earth's surface, which is being increasingly used by federal and provincial agencies and by private companies for agricultural crop inventory, forest and wildlife management, water resource management, updating topographical maps and aeronautical charts, land use mapping, and mineral and petroleum exploration.

The new, second generation technology included on LANDSAT-D will substantially improve earth resource survey capabilities by providing better colour and spatial resolution. However, in order to receive high resolution data, extensive electronic changes must be made to the two existing satellite receiving and data processing stations in Prince Albert, Saskatchewan and Shoe Cove, Newfoundland. Additional modifications to receive data from other nations' high resolution satellites, such as France's SPOT, will be relatively inexpensive.

The total cost of this project is $17.510M, for which $14.25M has been approved for the next three years.

Technology Transfer Program

This project calls for the negotiation of an agreement, initially with one interested province or territory, to

implement a technology transfer program that will lead to the integration of remote sensing data into resource management operations.

In order to ensure that maximum economic and social benefits of the data are achieved, Canada requires a strong training and technology transfer program jointly with the provinces to effectively integrate remote sensing technology into the nation's operational environmental and resource management information systems. The federal government would provide analysis equipment for a demonstration program as well as advice on the application of remote sensing techniques to practical problems through the use of an interdepartmental federal team of remote sensing and resource management specialists.

An amount of $0.50M has been approved to augment departmental resources in implementing this program through the next three years.

Radar Satellite Preliminary Development

This project consists of an R&D program with Canadian industry for the space and ground segments of a Synthetic Aperture Radar (SAR) system, which is intended to be a major component of a surveillance satellite program to be undertaken nationally or with chosen partners.

The positive results obtained through the Surveillance Satellite (SURSAT) program (1978-1980) have confirmed the value of satellite and airborne radar for a number of applications, including ship navigation in Arctic waters and all-weather surveillance of coastal zones. The SAR sensor is of great interest to Canada due to its capability to provide high resolution images of ocean and land areas, particularly in the Arctic and off the East and West Coasts, despite darkness or cloud cover. Technical studies and preliminary development activities will be undertaken to define in detail the elements, costs and risks of such cooperative undertakings after which a detailed submission requesting approval of the program will be made. Such a program will ensure the future availability of spaceborne SAR Data to Canada, and will develop a sovereign capability in a selected technological aspect of surveillance satellites and thereby permit Canada to be accepted as a strong contributing partner in international cooperative programs. In addition, the program would broaden the base of the Canadian space industry and develop opportunities for export sales in the surveillance satellite field. At the same time, an examination will be made of possible mechanisms through which

potential users of the system would contribute financially towards its development and operation.

An amount of $16.989M has been approved for the R&D program.

European Remote Sensing Program

In 1980, Canada's participation in the European Remote Sensing Preparatory Program (RSPP) was approved. This represents an attractive means for Canada to meet its future remote sensing data requirements for which Synthetic Aperture Radar technology is particularly suited. The current preparatory and definition phases will continue through 82/83, at which time the government should be in a position to take a decision on a longer-term Canadian radar satellite program.

The cost of Canada's continued participation in the RSPP, through to its termination in 82/83, is $4.07M.

Chlorophyll-A Sensor Study

In the context of this project, the Department of Fisheries and Oceans will conduct a sensor development study of a fluorescence line imager using multi-element array technology for chlorophyll-A monitoring, leading to a possible satellite sensor system. Preliminary negotiations of a cooperative program with potential foreign partners, in particular U.S.A. and Germany, for sensor development and satellite deployment, will also be initiated.

Recent spectrometer research confirms the correlation of the chlorophyll fluorescence emission and the measured chlorophyll concentration. The development of a satellite-borne fluorescence line imager would provide important data on worldwide primary productivity in the oceans. The fluorescence line imager would provide complementary data to the coastal zone colour scanner. The currently measured green to blue ratio of ocean reflectance for chlorophyll is accuracy-limited by atmospheric effects. The approved study will provide the information necessary to decide on building a satellite imaging system.

Interest has been expressed by German scientists in bilateral cooperation on Spacelab tests. Following this study and sensor tests, a decision will be needed on whether to proceed with the construction and implementation by Canadian industry of a satellite sensor system for use on platforms such as Spacelab or other environmental satellites.

This study will be completed in 82/83, at a total cost of $0.931M. New funding requirements, amounting to $0.466M, have been approved.

Meteorological Satellite Research and Development Program

The Atmospheric Environment Service of Environment Canada receives data and images of the earth and its atmosphere from operational and research meteorological satellites operated by th U.S.A. In order to employ the data thus received in a quantitative way so as to improve the accuracy of the forecast of weather, ice, and other environmental parameters and to increase the effectiveness of the total data acquisition system of the Service, certain systems and techniques will be examined and developed. These include:

(a) Completion, installation and verification of a system to combine satellite images with data from a weather radar to provide short-term precipitation and severe weather forecasts;

(b) Research and development of methods to convert radiances measured by polar-orbiting satellites into information on the structure of the atmosphere to reduce the dependence on sounding balloons;

(c) Completion, installation, and verification of the ice status system, and extension of it to enable mapping of snow cover and sea surface temperature; and

(d) Research and development to further enhance the capability of microwave space instruments to enable measurements of ice-cover, snow-cover, sea state, ocean surface winds and surface temperature.

The total cost of this program to 1985/86 is $6.01M; $3.33M has been approved for the next 3 years.

TECHNOLOGY DEVELOPMENT

L-SAT Program

The purpose of this project is to support continuèd Canadian involvement, particularly industrial, in the Large Satellite (L-SAT) Program of the European Space Agency (ESA).

Appendix III
(cont'd)

In July, 1979, seven ESA states (U.K., Italy, Netherlands, Switzerland, Belgium, Denmark, Spain) agreed to undertake a program with two essential objectives:

- the development of a multipurpose large platform designed for a range of future telecommunications applications on a basis that will maximize future competitiveness for sales in the world market; and

- the development and in-orbit demonstration of a payload which will advance European technology status, stimulate potential users and promote new markets.

The program comprises the development of a multipurpose large platform compatible with Ariane 3 and the Space Shuttle, employing equipment and technologies already existing or in advanced development, with new or more costly technology employed only where a sound case can be made for it; procurement and launch of a single flight model (supported by a flight spare); and operations support for the satellite lifetime. It is intended that the program be implemented so that strong emphasis is placed on preparing industry for future cost-competitive production of satellites to satisfy perceived markets. To achieve this, its essential elements are, in consequence:

- a satellite design which is conceived not only to keep development costs to a minimum, but also with a view to minimizing recurring costs while still meeting essential technical objectives; and

- the encouragement to industry to take the maximum initiative in order to become more self-sufficient and commercial in its approach.

Canadian participation could lead to increased exports of space subsystems and components in the commercialization phase of the program. In addition, access on favourable commercial terms to the spacecraft platform could be negotiated for use on domestic programs by the Canadian prime contractor. This would represent a considerable cost saving over developing such a spacecraft completely in Canada. The current participation in the definition phase will enable the opportunities offered by the program to be fully explored and assessed.

The current definition phase of the program will yield not only the detailed cost of the L-SAT program, but also the recurring cost of the L-SAT platform in future commercial

Appendix III
(cont'd)

programs. In late summer 1981, a decision will be taken by ESA on whether to proceed with the development and manufacturing phases. Canada will have to evaluate the potential advantages of its own continued involvement at that time.

The cost of participating in the full program could represent up to 15% of the overall program cost, currently estimated by ESA (1980 prices) at about $320 million. Funding amounting to $3.10M has been approved to cover the cost of Canada's continued participation in the remainder of the definition phase.

DOC Technology Development Program

This program is aimed primarily at funding contracts in industry for the development of space sub-systems and components. The continuing evolution of domestic space systems has enhanced the need for specific development work to establish the industry's credibility, in both the satellite and earth station markets. While industry is gradually increasing its share of the costs of such developments, strong support from the government is still required to maintain technological leadership and to match similar support given in other countries.

The additional costs of this program over the next three years amount to $9.930M.

Key Technology Studies

This projet has been instituted to assist industry in strengthening current capabilities and in diversifying into new technological applications. Included are new civil and military systems concepts, antenna and satellite radar developments and advanced fabrication methods.

An amount of $6.0M has been approved to cover the costs of such activities over the next three years.

Gallium Arsenide Device Development Capability

Gallium Arsenide (GaAs) integrated circuit fabrication technology is fundamental to the development of Very High Speed Integrated (VHSI) circuits and to the design of future electronic hardware and systems. The importance of this technology to the electronic industry has been recognized by

the governments of the U.S.A., Japan, U.K., France and Germany and they are giving substantial support to the development of such devices. A number of specific applications for these devices have been identified including the development of microwave earth terminals, amplifier systems and fast switching circuits for satellite communications and fibre optic systems.

Using a Canadian source of rare electronic materials, Canada has an opportunity to develop a Gallium Arsenide Field Effect Transistor (GaAsFET) device capability. This program will be carried out within the next three years and additional funding of $1.044M has been approved.

COMMUNICATIONS

Direct Broadcasting by Satellite (DBS) Program Development

Approximately one-quarter of Canada's population lives in regions with population densities between 1 and 2,500 persons per square mile, which are defined as being rural areas. The availability of television and radio programming in these areas is sharply less than in urban areas where cable systems, which are presently available to about 75% of Canada's population, together with over-air broadcasting, now provide a wide variety of radio and television programming. Outside of these urban areas, however, the availabilty of programs falls off sharply. Moreover, the quality of reception in rural and remote areas varies considerably. Even with such programs as the CBC's Accelerated Coverage Program and the significant improvement in communications in Northern Canada made possible by Telesat's satellite system, the disparity in level of service between the urban and the rural and remote regions of Canada continues to grow.

This project includes a comprehensive set of planning studies required to document a proposal for a possible DBS system. The studies will include: requirements statistics and market analysis; suitablity of ANIK-C for interim service; requirement for related services which could be delivered by a DBS; impact of DBS on the broadcasting industry; technical system modelling and technical studies; economic analysis, including comparison with alternatives for providing service to meet requirements; regulatory issues; impact of U.S. developments towards a DBS; and institutional arrangement options concerning matters such as financing, programming, etc.

Appendix III
(cont'd)

An event which introduces an element of urgency in carrying out these studies is the Regional Administrative Radio Conference of the ITU which will be held in 1983. This conference will develop the plan likely to be in effect for the next two decades for allocating the spectrum available for direct broadcasting satellites to all the countries in Region 2, which encompasses the Americas. It is imperative that Canadian plans be well developed to support our claim for a reasonable share of the spectrum, which is a scarce and limited resource.

Funding for these studies, amounting to $1.544M over the next two years (82/82 and 82/83), has been approved.

Controls Laboratory Expansion

Expansion of the DOC Controls Laboratory facilities is required to provide support for:

(a) Satellite system development and procurement by Canadian industry on active and planned programs (such as L-SAT, DBS and the proposed joint NASA/DOC mobile satellite program);

(b) related interdepartmental support for other aerospace programs (e.g., DND/DREO and NRCC); and

(c) on-going in-house projects related to long-term systems planning and development.

The Controls Laboratory at the Communications Research Center is a development and test facility for spacecraft control systems, components and devices. Alone, it can be used to test control sensors (such as earth and sun sensors, gyroscopes, accelerometers, momentum wheels and controllers). Used in conjunction with the Hybrid Computer of the Analysis and Simulation Laboratory, the performance of complete spacecraft attitude control and station-keeping systems can be defined with representative hardware - rather than with theoretical models. As component hardware becomes available, the component models simulated on the Hybrid Computer can be replaced with representative satellite hardware operating in the Controls Laboratory under test command and observation. In this way, potential systems can be evaluated and the risks of operational failure of a satellite system are reduced drastically. Operational reliability and predictability are

Appendix III
(cont'd)

therefore increased and overall costs of a satellite procurement program are decreased.

The Controls Laboratory and the associated Hybrid Computer facility are available for use by Canadian industry in support of satellite design and test activities as well as for analysis and development work by industry and government. The facility is presently unique in Canada.

The $0.41M required to upgrade this facility has been approved.

Increased DOC Space Sector Personnel Requirements

Satellite communications applications in Canada are increasing rapidly. During the 1970's Canada had one commercial satellite communications system - the ANIK-A series. For the 1980's, four different systems are expected to be in operation: the ANIK-A/D series, the ANIK-C series, a DBS system and a mobile satellite system. Planning and technological development for these future systems is placing a substantially increased workload on the Sector.

This increased use of satellites for public telecommunications is being paralleled by similar increases in other areas, e.g., remote sensing, navigation, search and rescue and various military applications of space systems. Because DOC is recognized as the centre of expertise within the government for spacecraft systems, there is a corresponding increase in the demand for DOC assistance in the planning and project management of such programs.

In addition to the efforts directed towards the development of a prime contractor for spacecraft in Canada, an increasing level of in-house resources is required for new technology development leading to technology transfer to industry, and for contract management associated with the program for the development in industry of space subsystems and components. Government support to industry in export market development also requires extra human resources, in the definition and negotiation of international cooperative programs (such as those now becoming available through Canada's Agreement of Cooperation with the European Space Agency (ESA)), and through technical and bid support to industry on international commercial procurements.

The costs associated with these additional resources, over the next three years, amount to $2.797M.

APPENDIX IV

ALLOCATION OF NEW FUNDS

CANADIAN SPACE PROGRAM PLAN FOR 1981/82 - 1983/84

	FY81/82	82/83	83/84	3YR TOTAL
REMOTE SENSING PROGRAM				
Radar Satellite Preliminary Development	3.000	6.855	7.134	16.989
Upgrade LANDSAT Stations	4.150	4.840	5.260	14.250
European Remote Sensing Preparatory Program	1.780	2.290	-	4.070
Technology Transfer to Remote Sensing Users	0.100	0.200	0.200	0.500
Chlorophyll A Sensor Study	0.264	0.202	-	0.466
Meteorological Satellite R&D	0.940	1.210	1.180	3.330
Sub-total	10.234	15.597	13.774	39.605
TECHNOLOGY DEVELOPMENT PROGRAM				
Key Technology Program	3.000	1.000	2.000	6.000
Accelerated Industry R&D	3.100	-	-	3.100
DOC Technology Development Programs	3.020	3.270	3.640	9.930
Gallium Arsenide Device Development	0.082	0.494	0.468	1.044
Sub-total	9.202	4.764	6.108	20.074
COMMUNICATIONS PROGRAM				
Broadcasting Satellite Studies (DBS)	0.895	0.649	-	1.544
Additional personnel for DOC	0.505	1.097	1.195	2.797
DOC Controls Laboratory Expansion	0.204	0.103	0.103	0.410
Sub-total	1.604	1.849	1.298	4.751
TOTAL	21.040	22.210	21.180	64.430